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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/501,711	07/19/2004	Tomoyoshi Yamashita	047991-5012	7142

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EXAMINER	
BENNETT, ZAHRA I	
ART UNIT	PAPER NUMBER
2875	

DATE MAILED: 01/10/2006

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	**Application No.** 10/501,711	**Applicant(s)** YAMASHITA ET AL.
	Examiner Zahra Bennett	**Art Unit** 2875

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *19 July 2004*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-36* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☒ Claim(s) *4-6* is/are allowed.

6)☒ Claim(s) *1,3,7,8,10,12,13,15-23,26,28,30,31,33 and 36* is/are rejected.

7)☒ Claim(s) *2,9,11,14,24,25,27,29,32,34 and 35* is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *19 July 2004* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☒ All b)☐ Some * c)☐ None of:

1.☒ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)

2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)

3) ☒ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date *7/19/2004*.

4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .

5) ☐ Notice of Informal Patent Application (PTO-152)

6) ☒ Other: *Translation - JP2000-353413A*.

DETAILED ACTION

Claim Rejections - 35 USC § 102

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

Claim 22 is rejected under 35 U.S.C. 102(b) as being anticipated by Chiba et al. (JP 2000-353413).

With respect to claim 22, Chiba teaches a light source device (Figure 1) comprising, at least, a primary light source (1), a light guide (3) that guides light emitted from the primary light source is incident, and a light outgoing surface (23) from which the guided light exits, a light deflector (4) having a light entrance surface (underside of 4) disposed adjacent to the light outgoing surface of the light guide and located so as to face the light outgoing surface (23), and a light exit surface (42) on an opposite side relative to the light entrance surface, and a light diffuser (5) having an incident surface disposed adjacent to the light exit surface of the light deflector, and an outgoing surface (top surface of 5) on an opposite side relative to the incident surface,

wherein the light diffuser is configured in such a manner that a full width half maximum of an outgoing luminous intensity distribution has an anisotropy when parallel light is incident thereon ([0034] lines 8-20).

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

Claims 1 and 3/1 are rejected under 35 U.S.C. 103(a) as being unpatentable over Chiba et al. (Translation of JP 2000-353413) in view of Colgan et al (US Patent 6,648,485) and Matsumoto (US Patent 6,502,947).

With respect to claim 1, Chiba teaches a light source device (Figure 1) comprising, at least, a primary light source (1), a light guide (3) that guides light emitted from the primary light source is incident, and a light outgoing surface (23) from which the guided light exits, a light deflector (4) having a light entrance surface (underside of 4) disposed adjacent to the light outgoing surface of the light guide and located so as to face the light outgoing surface (23), and a light exit surface (42) on an opposite side relative to the light entrance surface, and a light diffuser (5) having an incident surface disposed adjacent to the light exit surface of the light deflector, and an outgoing surface (top surface of 5) on an opposite side relative to the incident surface,

wherein a plurality of elongated prisms (Figure 2), arrayed side by side, are formed at the light entrance surface of the light deflector, each of the elongated prisms has two prism surfaces (41).

Chiba does not teach that at least one of the prism surfaces is formed into a convex curved shape. In a similar device, Matsumoto teaches that at least one of the prism surfaces is formed into a convex curved shape (Column 5, lines 31-50). It would have been obvious to one of ordinary skill at the time of the invention to form of the prisms surfaces into a convex curved shape. One would have motivated to modify the device of Chiba for the benefit of facilitating the precise formation of the minute elongated prisms on the light guide and to enhance the durability of the light guide, as taught by Matsumoto.

Chiba does not teach that the light luminous intensity distribution is 1 to 13 degrees. Colgan teaches that the light diffuser is configured in such a manner that a full width half maximum of an outgoing light luminous intensity distribution is 1 to 13 degrees when parallel light is incident thereon (Column 1, lines 35-42). It would have been obvious to arrange light luminous intensity at 1 to 13 degrees. One would have been motivated to modify the device of Chiba for the benefit of enhancing the front intensity of the image display unit, as taught by Colgan.

With respect to claim 3/1, Matsumoto teaches that an average inclination angle of at least one of the incident surface and the outgoing surface of the light diffuser is 0.8 to 12 degrees (Column 6, lines 43-56).

With respect to claim 15, Chiba teaches that a developed length of the light guide is greater than 8cm and equal to or less than 28cm ([0038] lines 7-8). Chiba does not teach that the average inclination of at least one of the incident

surface and the outgoing surface of the light diffuser is 3 to 9.5 degrees. Matsumoto teaches that an average inclination angle of at least one of the incident surface and the outgoing surface of the light diffuser is 3 to 9.5 degrees (Column 6, lines 43-56). It would have been obvious to one of ordinary skill at the time of the invention to have the light diffuser 3 to 9.5 degrees. One would have been motivated to modify the device of Chiba for the benefit of enhancing the front intensity of the image display unit, as taught by Matsumoto.

Claims 7, 8,10, and 13 are rejected under 35 U.S.C. 103(a) as being unpatentable over Chiba et al. (JP 2000-353413) further in view of Colgan et al (US Patent 6,648,485) and Matsumoto (US Patent 6,502,947).

With respect to claim 7, Chiba teaches a light source device (Figure 1) comprising, at least, a primary light source (1), a light guide (3) that guides light emitted from the primary light source is incident, and a light outgoing surface (23) from which the guided light exits, a light deflector (4) having a light entrance surface (underside of 4) disposed adjacent to the light outgoing surface of the light guide and located so as to face the light outgoing surface (23), and a light exit surface (42) on an opposite side relative to the light entrance surface, and a light diffuser (5) having an incident surface disposed adjacent to the light exit surface of the light deflector, and an outgoing surface (top surface of 5) on an opposite side relative to the incident surface,

wherein a plurality of elongated prisms (Figure 2), arrayed side by side, are formed at the light entrance surface of the light deflector. Each of the elongated prisms has two prism surfaces (41).

Chiba does not teach that at least one of the prism surfaces is formed into a convex curved shape. In a similar device, Matsumoto teaches that at least one of the prism surfaces is formed into a convex curved shape (Column 5, lines 31-50). It would have been obvious to one of ordinary skill at the time of the invention to form of the prisms surfaces into a convex curved shape. One would have motivated to modify the device of Chiba for the benefit of facilitating the precise formation of the minute elongated prisms on the light guide and to enhance the durability of the light guide, as taught by Matsumoto.

Chiba does not teach that the average inclination angle of at least one of the incident surface and the outgoing surface of the light diffuser is 0.8 to 12 degrees. Matsumoto teaches that an average inclination angle of at least of the incident surface and the outgoing surface of the light diffuser is 0.8 to 12 degrees (Column 6, lines 43-56). It would have been obvious to one of ordinary skill at the time of the invention to have the light diffuser 0.8 to 12 degrees. One would have been motivated to modify the device of Chiba for the benefit of enhancing the front intensity of the image display unit, as taught by Matsumoto.

With respect to claim 8, Matsumoto does not teach that the light luminous intensity distribution is 1 to 13 degrees. Colgan teaches that the light diffuser is configured in such a manner that a full width half maximum of an outgoing light

luminous intensity distribution is 1 to 13 degrees when parallel light is incident thereon (Column 1, lines 35-42). It would have been obvious to arrange the light luminous intensity at 1 to 13 degrees. One would have been motivated to modify the device of Chiba for the benefit of enhancing the front intensity of the image display unit, as taught by Colgan.

With respect to claim 10, Matsumoto teaches that a developed length of the light guide is 8cm or less (Column 11, line 69 to Column 12, line1). Matsumoto does not teach that the full width half maximum is 1 to 6. Colgan teaches that the light diffuser is configured in such a manner that the full width half maximum of an outgoing light luminous intensity distribution is 1 to 6 degrees when parallel light is incident thereon (Column 1, lines 35-42). It would have been obvious to arrange the light luminous intensity at 1 to 13 degrees. One would have been motivated to modify the device of Chiba for the benefit of enhancing the front intensity of the image display unit, as taught by Colgan.

With respect to claim 13, Chiba teaches that the length of the light guide is greater than 8cm and equal to or less than 23cm ([0038] lines 7-8). Chiba does not teach of that the luminous intensity is 3 to 11 degrees. Colgan teaches that the light diffuser is configured in such a manner that a full width half maximum of an outgoing light luminous intensity distribution is 3 to 11 degrees when parallel light is incident thereon (Column 1, lines 35-42). It would have been obvious to arrange the light luminous intensity at 3 to 11 degrees. One would have been

motivated to modify the device of Chiba for the benefit of enhancing the front intensity of the image display unit, as taught by Colgan.

Claim 12 is rejected under 35 U.S.C. 103(a) as being unpatentable over Chiba et al., Matsumoto et al., and Colgan, as applied to claim 1 and 3 above, and further in view of Ochiai (US Patent 5,703,667).

With respect to claim 12, Chiba, Matsumoto, and Colgan do not teach that the light guide is less that 8cm, and the outgoing surface of the light diffuser is 0.8 to 5 degrees. Ochiai teaches that a developed length of the light guide is 8cm or less (Column 1, lines 35-37), and a maximum average inclination angle of at least one of the incident surface and the outgoing surface of the diffuser is 0.8 to 5 degrees (Column 5, lines 18-20). It would have been obvious to one of ordinary skills at the time of the invention to teach that the light guide 8cm or less, and a maximum average inclination angle of at least one of the incident surface and the outgoing surface of the light diffuser is 0.8 to 5 degrees. One would have been motivated to modify the devices of Chiba, Matsumoto, and Colgan for the benefit of enabling the light guide to receive on its entire surface light rays which are incident and practically horizontally from the light source as taught by Ochiai.

Claim 16 is rejected under 35 U.S.C. 103(a) as being unpatentable over Chiba et al. (JP 2000-353413) further in view of Colgan et al (US Patent 6,648,485) and Matsumoto (US Patent 6,502,947).

With respect to claim 16, Chiba teaches a light source device (Figure 1) comprising, at least, a primary light source (1), a light guide (3) that guides light emitted from the primary light source is incident, and a light outgoing surface (23) from which the guided light exits, a light deflector (4) having a light entrance surface (underside of 4) disposed adjacent to the light outgoing surface of the light guide and located so as to face the light outgoing surface (23), and a light exit surface (42) on an opposite side relative to the light entrance surface, and a light diffuser (5) having an incident surface disposed adjacent to the light exit surface of the light deflector, and an outgoing surface (top surface of 5) on an opposite side relative to the incident surface,

wherein a plurality of elongated prisms (Figure 2), arrayed side by side, are formed at the light entrance surface of the light deflector, each of the elongated prisms has two prism surfaces (41).

Chiba does not teach that at least one of the prism surfaces is formed into a convex curved shape. In a similar device, Matsumoto teaches that at least one of the prism surfaces is formed into a convex curved shape (Column 5, lines 31-50). It would have been obvious to one of ordinary skill at the time of the invention to form of the prisms surfaces into a convex curved shape. One would have motivated to modify the device of Chiba for the benefit of facilitating the precise formation of the minute elongated prisms on the light guide and to enhance the durability of the light guide, as taught by Matsumoto.

Chiba does not teach that a full half width maximum of a luminance distribution of outgoing light from the light exit surface of the light deflector is 19

to 26 degrees, and the light luminous intensity distribution is 1 to 8 degrees. Colgan teaches that a full width half maximum of a luminance of outgoing light from the light exit surface of the light deflector is 19 to 26 degree (Column 1, lines 28-30), and the light diffuser is configured in such a manner that a full width half maximum of an outgoing light luminous intensity distribution is 1 to 8 degrees when parallel light is incident thereon (Column 1, lines 35-42). It would have been obvious to arrange a full half width maximum of a luminance distribution of outgoing light from the light exit surface of the light deflector at 19 to 26 degrees, and the light luminous intensity at 1 to 8 degrees. One would have been motivated to modify the device of Chiba for the benefit of enhancing the front intensity of the image display unit, as taught by Colgan.

With respect to claim 18, Matsumoto teaches that an average inclination angle of at least of the incident surface and the outgoing surface of the light diffuser is 0.8 to 7 degrees (Column 6, lines 43-56).

Claim 17 is rejected under 35 U.S.C. 103(a) as being unpatentable over Chiba et al., Matsumoto et al., and Colgan, as applied to claim 16 above, and further in view of Uchida et al. (US Patent 6,805,925).

With respect to claim 17, Chiba, Matsumoto, and Colgan do not teach that the haze value is 8 to 70%. Uchida teaches that the haze value is 8 to 70% (Column 7, lines 68-69). It would have been obvious to one of ordinary skill at the time of the invention to teach that the haze value is 8 to 70%. One would

have been motivated to modify the devices of Chiba, Matsumoto, and Colgan for the benefit of scattering the diffused light adequately as taught by Uchida.

Claim 19 is rejected under 35 U.S.C. 103(a) as being unpatentable over Chiba et al. (JP 2000-353413) further in view of Matsumoto et al. (US Patent 6,502,947), Colgan (US Patent 6,648,485), and Winston et al. (US Patent 6,044,196).

With respect to claim 19, Chiba teaches a light source device (Figure 1) comprising, at least, a primary light source (1), a light guide (3) that guides light emitted from the primary light source is incident, and a light outgoing surface (23) from which the guided light exits, the light guide having a developed length greater than 8cm and equal to or less than 28cm ([0038] lines 7-8), a light deflector (4) having a light entrance surface (underside of 4) disposed adjacent to the light outgoing surface of the light guide and located so as to face the light outgoing surface (23), and a light exit surface (42) on an opposite side relative to the light entrance surface, and a light diffuser (5) having an incident surface (41) disposed adjacent to the light exit surface of the light deflector, and an outgoing surface (top surface of 5) on an opposite side relative to the incident surface,

wherein a plurality of elongated prisms (Figure 2), arrayed side by side, are formed at the light entrance surface of the light deflector, each of the elongated prisms has two prism surfaces (41).

Chiba does not teach that at least one of the prism surfaces is formed into a convex curved shape. In a similar device, Matsumoto teaches that at least one

of the prism surfaces is formed into a convex curved shape (Column 5, lines 31-50). It would have been obvious to one of ordinary skill at the time of the invention to form of the prisms surfaces into a convex curved shape. One would have motivated to modify the device of Chiba for the benefit of facilitating the precise formation of the minute elongated prisms on the light guide and to enhance the durability of the light guide, as taught by Matsumoto.

Chiba does not teach that the light luminous intensity distribution is 0.7 to 13 degrees. Colgan teaches that the light diffuser is configured in such a manner that a full width half maximum of an outgoing light luminous intensity distribution is 0.7 to 13 degrees when parallel light is incident thereon (Column 1, lines 35-42). It would have been obvious to arrange the light luminous intensity at 0.7 to 13 degrees. One would have been motivated to modify the device of Chiba for the benefit of enhancing the front intensity of the image display unit, as taught by Colgan.

Chiba does not teach two primary light sources. In a similar device, Winston teaches two primary light sources which are disposed on opposite sides to each other (Figure 13: 278). It would have been obvious to one of ordinary skill at the time of the invention to have two primary light sources on the device of Chiba for the benefit of increasing the illumination as taught by Winston.

With respect to claim 20, Matsumoto teaches that an average inclination angle of the incident surface (Figure 1: 21) of the light diffuser is greater than

average inclination angle of the outgoing surface (23) thereof (Column 7, lines 58-68).

With respect to claim 21, Matsumoto teaches that at least one of the prism surfaces is formed into a convex curved shape (Column 5, lines 31-50). It would have been obvious to one of ordinary skill at the time of the invention to form of the prisms surfaces into a convex curved shape. One would have motivated to modify the device of Chiba for the benefit of facilitating the precise formation of the minute elongated prisms on the light guide and to enhance the durability of the light guide, as taught by Matsumoto.

Claims 22, 23, 26, and 31 are rejected under 35 U.S.C. 103(a) as being unpatentable over Chiba et al. (JP 2000-353413), as applied to claim 22 above and further in view of Colgan (US Patent 6,648,485).

With respect to claim 23, Chiba does not teach that the light luminous intensity distribution is 1 to 13 degrees. Colgan teaches that the light diffuser is configured in such a manner that a full width half maximum of an outgoing light luminous intensity distribution is 1 to 13 degrees when parallel light is incident thereon (Column 1, lines 35-42). It would have been obvious to arrange the light luminous intensity at 1 to 13 degrees. One would have been motivated to modify the device of Chiba for the benefit of enhancing the front intensity of the image display unit, as taught by Colgan.

With respect to claim 26, Chiba does not teach that an average inclination angle of at least one of the incident surface and the outgoing surface of the light diffuser has an anisotropy. Colgan teaches that an average inclination angle of at least one of the incident surface and the outgoing surface of the light diffuser has an anisotropy (Column 1, lines 35-42). It would have been obvious to one of ordinary skill at the time of the invention to have an average inclination angle of at least one of the incident surface and the outgoing surface of the light diffuser has an anisotropy. One would have been motivated to modify the device of Chiba for the benefit of enhancing the front intensity of the image display unit, as taught by Colgan.

With respect to claim 31, Chiba teaches that the length of the light guide is greater than 8cm and equal to or less than 23cm. Chiba does not teach that the light diffuser is configured in such a manner that the maximum full width half maximum of the outgoing light luminous intensity distribution is 3 to 13 degrees when the parallel light is incident thereon. Colgan teaches that the light diffuser is configured in such a manner that a full width half maximum of an outgoing light luminous intensity distribution is 3 to 13 degrees when parallel light is incident thereon (Column 1, lines 35-42). It would have been obvious to arrange the light luminous intensity at 3 to 13 degrees. One would have been motivated to modify the device of Chiba for the benefit of enhancing the front intensity of the image display unit, as taught by Colgan.

Claims 33, 34, and 36 are rejected under 35 U.S.C. 103(a) as being unpatentable over Chiba et al. (JP 2000-353413), as applied to claim 22 above and further in view of Matsumoto et al. (US Patent 6,502,947).

With respect to claim 33, Chiba teaches that the length of the light guide is greater than 8cm and equal to or less than 23cm. Chiba does not teach that a maximum average inclination angle of at least one of the incident surface and the outgoing surface of the light diffuser is 3 to 15 degrees. Matsumoto teaches that a maximum average inclination angle of at least of the incident surface and the outgoing surface of the light diffuser is 0.8 to 12 degrees (Column 6, lines 43-45). It would have been obvious to arrange the outgoing surface of the light diffuser at 0.8 to 12 degrees. One would have been motivated to modify the device of Chiba for the benefit of enhancing the front intensity of the image display unit, as taught by Matsumoto.

With respect to claim 34, Chiba does not teach that a maximum inclination angle of the incident surface of the light diffuser is greater than a minimum average inclination angle of the outgoing surface. Matsumoto teaches that a maximum average inclination angle of the incident surface (Figure 1: 21) of the light diffuser is greater than a minimum average inclination angle of the outgoing surface (23) thereof (Column 7, lines 58-68). It would have been obvious to have a maximum inclination angle of the incident surface of the light diffuser greater than a minimum average inclination angle of the outgoing surface. One would

have been motivated to modify the device of Chiba for the benefit of enhancing the front intensity of the image display unit, as taught by Matsumoto.

With respect to claim 36, Chiba does not teach that at least one of the prism surfaces is formed into a convex curved shape. Matsumoto teaches that at least one of the prism surfaces is formed into a convex curved shape (Column 5, lines 31-50). It would have been obvious to one of ordinary skill at the time of the invention to form of the prisms surfaces into a convex curved shape. One would have motivated to modify the device of Chiba for the benefit of facilitating the precise formation of the minute elongated prisms on the light guide and to enhance the durability of the light guide, as taught by Matsumoto.

Claims 28 and 30 are rejected under 35 U.S.C. 103(a) as being unpatentable over Chiba et al., Matsumoto et al., and Colgan, as applied to claim 22 above, and further in view of Ochiai (US Patent 5,703,667).

With respect to claim 28, Colgan teaches that the light diffuser is configured in such a manner that the maximum full width half maximum of the outgoing light luminous intensity distribution is 1 to 6 degrees when the parallel light is incident (Column 1, lines 35-42). Chiba, Matsumoto, and Colgan do not teach that the light guide is 8cm or less. Ochiai teaches that a developed length of the light guide is 8cm or less (Column 1, lines 35-37). It would have been obvious to one of ordinary skills at the time of the invention to teach that the light

guide 8cm or less. One would have been motivated to modify the devices of Chiba, Matsumoto, and Colgan for the benefit of enabling the light guide to receive on its entire surface light rays which are incident and practically horizontally from the light source as taught by Ochiai.

With respect to claim 30, Chiba, Matsumoto, and Colgan do not teach that the light guide is less that 8cm, and the outgoing surface of the light diffuser is 0.8 to 5 degrees. Ochiai teaches that a developed length of the light guide is 8cm or less (Column 1, lines 35-37), and a maximum average inclination angle of at least one of the incident surface and the outgoing surface of the diffuser is 0.8 to 5 degrees (Column 5, lines 18-20). It would have been obvious to one of ordinary skills at the time of the invention to teach that the light guide 8cm or less, and a maximum average inclination angle of at least one of the incident surface and the outgoing surface of the light diffuser is 0.8 to 5 degrees. One would have been motivated to modify the devices of Chiba, Matsumoto, and Colgan for the benefit of enabling the light guide to receive on its entire surface light rays which are incident and practically horizontally from the light source as taught by Ochiai.

Allowable Subject Matter

Claims 4-6 are allowed.

Claims 2, 3/2, 9, 11,12/2,14,15/2, 24, 25, 27, 29, 32, and 35 are objected to as being dependent upon a rejected base claim, but would be allowable if

rewritten in independent form including all of the limitations of the base claim and any intervening claims.

The following is an examiner's statement of reasons for allowance: The prior art fails to show or disclose a similar device with particular haze values claimed. The prior art also fails to show or disclose that the average inclination angle of the incident surface of the light diffuser is 1.1 times a minimum average inclination the angle thereof.

Any comments considered necessary by applicant must be submitted no later than the payment of the issue fee and, to avoid processing delays, should preferably accompany the issue fee. Such submissions should be clearly labeled "Comments on Statement of Reasons for Allowance."

Conclusion

The prior art made of record and not relied upon is considered pertinent to applicant's disclosure. Kashima et al. (US Patent 5,730,518) teaches the haze value of the diffuser is 0.5 to 50%. Torihara et al. (US Patent 6,412,969) teaches that the haze value of the diffuser is 78 to 82%. Brown et al. (US Patent 6,799,868) teaches that the full width half maximum in the parallel direction is 8 to 12 degrees.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Zahra Bennett whose telephone number is 571-272-2267. The examiner can normally be reached on Monday-Friday.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Renee Luebke can be reached on 571-272-2009. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

RENEE LUEBKE
PRIMARY EXAMINER

PTO 06-1242

Japanese Kokai Patent Application
No. P2000-353413A

FACE LIGHT SOURCE ELEMENT AND LENS SHEET

Kazukiyo Chiba and Masaharu Ota

UNITED STATES PATENT AND TRADEMARK OFFICE
WASHINGTON, D.C. DECEMBER 2005
TRANSLATED BY THE RALPH MCELROY TRANSLATION COMPANY

JAPANESE PATENT OFFICE
PATENT JOURNAL (A)
KOKAI PATENT APPLICATION NO. P2000-353413A

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No. of Claims:	10 (Total of 8 pages; OL)
Examination Request:	Not filed

FACE LIGHT SOURCE ELEMENT AND LENS SHEET

[Men kogen soshi oyobi renzu shito]

Inventors:	Kazukiyo Chiba and Masaharu Ota
Applicant:	Mitsubishi Rayon Co., Ltd.

[There are no amendments to this patent.]

Claims /2*

1. A type of face light source element characterized by the fact that it is composed of a light source, a light guiding member having at least one light incident plane facing said light source and a light exit plane nearly perpendicular to said light incident plane, a light deflecting

* [Numbers in the right margin indicate pagination of the original language text.]

element set on the light exit plane of said light guiding member, and a light diffusion element set on the light output plane of said light deflecting element and with diffusion rate of 5-10%.

2. A type of face light source element characterized by the fact that it is composed of a light source, a light guiding member having at least one light incident plane facing said light source and a light exit plane nearly perpendicular to said light incident plane, and a light deflecting element set on the light exit plane of said light guiding member; and the light deflecting element has a lens plane with plural lens columns set consecutively on at least one surface of a light diffusion sheet with a diffusion rate of 5-10%.

3. The face light source element described in Claim 1 or 2 characterized by the fact that for said light guiding member, the angle of the principal light rays exiting from the light exit plane with respect to the normal of the light exit plane is in the range of 50-80°C, and the full width at half maximum of the luminous intensity on the plane perpendicular to both the light incident plane and the light exit plane is 50° or smaller.

4. The face light source element described in Claim 1 or 2 characterized by the fact that the total light ray transmittance of said light diffusion element is 65% or higher.

5. The face light source element described in Claim 1 or 2 characterized by the fact that at least one surface of said light diffusion element is a rough surface.

6. The face light source element described in Claim 1 or 2 characterized by the fact that the light output exit rate of said light guiding member is in the range of 0.5-5%.

7. The face light source element described in Claim 1 characterized by the fact that said light deflecting element has a lens plane with plural lens columns set side-by-side consecutively on at least one surface, and said lens plane is set on the light exit plane of the light guiding member so that it faces the light exit plane of the lens plane.

8. The face light source element described in Claim 2 characterized by the fact that said light deflecting element is a prism sheet that has a prism plane with prism columns with nearly triangular cross-sectional shape formed consecutively on at least one surface of the light diffusion sheet with diffusion rate in the range of 5-10%.

9. A type of lens sheet for face light source element characterized by the fact that it has a lens plane with plural lens columns set side-by-side consecutively on at least one surface of a light diffusion sheet with diffusion rate in the range of 5-10%.

10. The lens sheet for face light source element described in Claim 9 characterized by the fact that said lens plane is a prism plane with plural prism columns having nearly triangular cross-sectional shape set side-by-side consecutively.

Detailed explanation of the invention

[0001]

Industrial application field

The present invention pertains to a type of face light source element of an edge light system for use in notebook computers, liquid crystal television sets, etc. More specifically, the present invention pertains to a type of face light source element having a high luminance and, at the same time, having a distribution of the exit light controlled to have the desired viewing angle range.

[0002]

Prior art

In recent years, color liquid crystal display devices have been widely used in various fields, such as portable notebook personal computers, portable liquid crystal television sets and video integrated liquid crystal television sets using color liquid crystal panels, etc. Also, with the increase in the information processing quantity, increase in the types of requirements, efforts to cope with multimedia, etc., progress has been made in developing larger screens and higher precision of the liquid crystal display devices.

[0003]

Said liquid crystal display device is basically composed of a backlight part and a liquid crystal display element part. The [currently available] types of the backlight parts include the right-below system with light source set right below the liquid crystal display element part, and the edge light system with a light source set facing the side end surface of a light guiding member. From the viewpoint of compactness of the liquid crystal display device, the edge light system is often adopted. In the edge light system, a light source is set facing the side end surface of a plate-shaped light guiding member to form a face light source element the emits light from the entire surface of the light guiding member.

[0004]

However, for the notebook computers, liquid crystal television sets, and other devices using color liquid crystal display devices, batteries are used as the power source so that they can be carried around. Most of the power is consumed by the liquid crystal display device. The proportion of the power consumption by the backlight in the liquid crystal display device is especially large. Consequently, reduction of the power consumption becomes an important topic as it can prolong the operating time of the device and to improve the practical application value of the liquid crystal display device. However, reduction of the power consumption of backlight

leads to decrease in the backlight luminance, so that the contrast of the liquid crystal display becomes lower and the display becomes hard to view. This is undesirable.

[0005]

Problems to be solved by the invention

A method has been proposed in which while the power consumption of backlight can be reduced, the distribution of the exit light is made narrower so that the luminance is not significantly sacrificed. However, the viewing angle range of the liquid crystal display is too narrow for some applications, and this is undesirable. For example, Japanese Kokai Utility Model Application No. Hei 7[1995]-27137 disclosed a type of backlight characterized by the fact that a light guiding member with a rough-surface light exit plane is used, and a prism sheet having plural prism columns set as an array is set on the light exit plane of the light guiding member such that its prism plane becomes the light guiding member side. However, for this type of backlight, although a high luminance is obtained, the distribution of the exit light in the vertical direction with respect to a linear light source becomes narrower. As a result, although it may be used in small sized liquid crystal display devices, and other devices that do not require a large viewing angle range, it nevertheless cannot be used in large sized liquid crystal display devices and other devices that require a large viewing angle range. This is undesirable.

[0006]

In order to solve said problems, for example, Japanese Kokai Patent Application No. Hei 10[1998]-160914 proposed a scheme in which a prism sheet is set on the light exit plane of a /3 light guiding member such that its prism plane becomes the light guiding member side, and a light diffusion layer is formed on the light exit plane of the prism sheet. However, in such backlight, although the viewing angle range that requires a luminance distribution can be made larger, the decrease in the luminance nevertheless is too much, and this is undesirable.

[0007]

The purpose of the present invention is to provide a type of face light source element characterized by the fact that for the face light source element with a constitution to obtain a high luminance as disclosed in Japanese Kokai Utility Model Application No. Hei 7[1995]-27137, while the high luminance can be maintained, the desired wide viewing angle range can be guaranteed, as well as a type of a lens sheet used in said face light source element.

[0008]

Means to solve the problems

In consideration of the aforementioned problems, the present inventors have found that by setting a prescribed light diffusion element on a light deflecting element, it is possible to control the distribution of the exit light in the perpendicular direction with respect to the light incident plane of the light guiding member and to increase the viewing angle range, without a decrease in the luminance. As a result, the present invention was reached.

[0009]

That is, the present invention provides a type of face light source element characterized by the fact that it is composed of a light source, a light guiding member having at least one light incident plane facing said light source and a light exit plane nearly perpendicular to said light incident plane, a light deflecting element set on the light exit plane of said light guiding member, and a light diffusion element set on the light output plane of said light deflecting element; said light deflecting element deflects the exit light from the light guiding member with respect to the light exit plane of the light guiding member; and the diffusion rate of said light diffusion element is in the range of 5-10%. Also, this invention provides a type of face light source element characterized by the fact that it is composed of a light source, a light guiding member having at least one light incident plane facing said light source and a light exit plane nearly perpendicular to said light incident plane, and a light deflecting element set on the light exit plane of said light guiding member; and the light deflecting element has a lens plane with plural lens columns set consecutively on at least one surface of a light diffusion sheet with a diffusion rate of 5-10%. In addition, the present invention provides a type of lens sheet for face light source element characterized by the fact that it has a lens plane with plural lens columns set side-by-side consecutively on at least one surface of a light diffusion sheet with diffusion rate in the range of 5-10%.

[0010]

Embodiment of the present invention

In the following, an explanation will be given regarding the embodiment of the present invention with reference to the figures. Figure 1 is a schematic exploded view illustrating a typical embodiment of the face light source element of the present invention. As shown in Figure 1, the face light source element of the present invention is composed of light guiding member (3) that has at least one side end surface as light incident plane (21), and a surface nearly perpendicular to it as light exit plane (23), light source (1) set facing light incident plane (21) of said light guiding member (3) and covered with light source reflector (2), light deflecting

element (4) set on the light exit plane of light guiding member (3), reflective element (6) set on inner surface (24) of light exit plane (23) of light guiding member (3), and light diffusion element (5) set on light deflecting element (4). Also, in the figure, (7) represents a shielding member for preventing bright lines and dark lines near the lamp, and it is set as needed.

[0011]

Said light guiding member (3) has an overall rectangular shape, and it is set parallel to the XY plane. Said light guiding member (3) has four side end surfaces, and at least one side end surface of one pair of side end surfaces taken as light incident plane (21). Said light incident plane (21) is set facing light source (1), and the light emitted from light source (1) is incident into light guiding member (3) from light incident plane (21). According to the present invention, for example, a light source may also be set on side end surface (22) opposite to light incident plane (21). The two principal planes that are nearly perpendicular to light incident plane (21) of light guiding member (3) are set facing each other. They are positioned parallel to XY plane, and one of them becomes light exit plane (23). Among said light exit plane (23) and its inner surface (24), at least one side is processed as a rough surface or other directional light exit function so that light with directionality exits from light exit plane (23).

[0012]

Also, on the principal surface without processing to have the directional light exit function, it is also possible to form a lens plane having plural lens columns set as an array extending in the direction (X direction) nearly perpendicular to light incident plane (21). In the embodiment shown in Figure 1, a rough surface is formed on light exit plane (23), and a lens plane having plural lens columns set side-by-side and extending in the direction (X direction) nearly perpendicular to light incident plane (21) is formed on inner surface (24). According to the present invention, opposite to the state shown in Figure 1, light exit plane (23) is formed as a lens plane, and inner surface (24) is formed as a rough surface.

[0013]

For said light guiding member (3), the light exit rate should be in the range of 0.2-5%, or preferably in the range of 0.5-4%, or more preferably in the range of 1-3%. If the light exit rate is lower than 0.2%, the light quantity exit from light guiding member (3) becomes small, so that a sufficient luminance cannot be obtained. As the light exit rate is higher than 5%, a large quantity exits from near light source (1), attenuation of light in X direction within light exit plane (23) becomes significant, and the uniformity of luminance on light exit plane (23) tends to become poorer. By having the light exit rate of light guiding member (3) in the range of 0.2-5%, it is

possible to have a highly directional exit light beam, for which the angle of the principal exit light from light exit plane (23) with respect to the normal (Z direction) of light exit plane (23) is in the range of 50-80°, and the full width at half maximum of the luminous intensity on the plane (XZ plane) perpendicular to both the light incident plane and light exit plane of 50° or smaller. This is especially preferred as the light guiding member of the face light source element with constitution of the present invention. Also, for said light guiding member, the full width at half maximum of the luminous intensity of the exit light on the plane (YZ plane) containing said principal exit light and perpendicular to said perpendicular plane becomes about 35-65°. According to the present invention, light deflecting element (4) can deflect the exit light from said light guiding member (3) to a desired exit direction, such as the normal direction of light exit plane (23) (Z direction). As a result, a face light source element with a high luminance is provided.

[0014] /4

According to the present invention, the light exit rate from light guiding member (3) is defined as follows. Suppose the thickness (Z-direction dimension) of light guiding member (3) is t, the following relationship (1) is met between light intensity (I0) of the exit light at the end edge of light incident plane (21) side of light exit plane (23) and exit light intensity (I) at position of distance L from the end edge on the light incident plane (21) side.

[0015]

[Formula 1]

$$I = I_0 \cdot \alpha \cdot (1-\alpha)^{L/t} \quad \cdots \quad (1)$$

Here, constant α is the light exit rate, the proportion (%) of light exit from light guiding member (3) for unit length (the length corresponding to thickness t of the light guiding member) in X direction perpendicular to light exit plane (23) and light incident plane (21). The light exit rate α can be determined from the gradient of the plot (L/t) with ordinate representing the light intensity of the exit light from light exit plane (23) and with abscissa representing the logarithmic of the light intensity of the exit light from light exit plane (23). Said light exit rate α significantly depends on the magnitude and shape of the bumps and dips of the rough surface. However, as shown in Figure 1, when the lens columns are formed on inner surface (24), as light is incident on the lens plane, the propagating direction of the light in light guiding member (3) is bent, or, when the light is incident at an incident angle smaller than the critical angle with respect to the lens plane, the light exist out of light guiding member (3), and it is reflected by reflective

element (6) and is re-incident. Consequently, light exit rate α does not depend only on the state of the rough surface of light exit plane (23).

[0016]

According to the present invention, in order to ensure that exit light with a high directionality exits from light guiding member (3), rough surface and lens columns (the lens columns are set side-by-side and extending in the direction parallel to the incident plane of the light guiding member) are formed and/or light diffusion micron grains are contained in light guiding member (3). In addition, in order to ensure a high uniformity of the luminance on the entire light exit plane of light guiding member (3), it is preferred that the light exit rate of light guiding member (3) due to the directional exit function be in the range of 0.2-5%.

[0017]

According to the present invention, light exit rate α of light guiding member (3) is closely related to the average slope angle θa of the rough surface or lens columns or the proportion of the fine light diffusion grains contained in the light guiding member, and it can be adjusted by changing the average slope angle θ of the rough surface or the lens columns formed on the surface of light guiding member (3) or the mixing proportion of the fine light diffusion grains. Also, for light guiding member (3) of the present invention, the propagating direction of light in light guiding member (3) may be changed by the prism columns formed on light exit plane (23) or inner surface (24), or the propagating direction of light may be changed by having the light in light guiding member (3) incident at an incident angle smaller than the critical angle with respect to the inner surface, refracted to exit out of light guiding member (3) and then re-incident in it. Consequently, light exit rate α does not depend only on the average slope angle θa of the rough surface or the lens columns formed on the surface of light guiding member (3) and the mixing proportion of the fine light diffusion grains.

[0018]

From the viewpoint of uniformity of luminance on light exit plane (23), it is preferred that the average slope angle θa of the rough surface or the lens columns formed on the surface of light guiding member (3) be in the range of 0.5-7.5°. This average slope angle θa is related to exit rate α of light guiding member (3). As average slope angle θa becomes larger, exit rate α tends to become larger. Consequently, when average slope angle θa becomes smaller than 0.5, there is a tendency that exit rate α of light guiding member (3) becomes smaller, the exit quantity of the light from light guiding member (3) becomes smaller, and the luminance becomes lower. On the other hand, when average slope angle θa is larger than 7.5°, there is a tendency that exit

rate α of light guiding member (3) becomes higher, most of the light in the region near light source (1) of light exit plane (23) exits, and as the position goes away from light source (1), the attenuation of light propagating in light guiding member (3) becomes higher. Also, as the position leaves light source (1), there is a tendency that the exit light from light exit plane (23) becomes rapidly attenuated, and the uniformity of the luminance on light exit plane (23) becomes lower. The average slope angle θa is preferably in the range of 1-5°, or more preferably in the range of 1.5-4°.

[0019]

Average slope angle θa of the rough surface formed on light guiding member (3) can be determined according to ISO 4287/1-1984. In this case, a probe type surface roughness meter is used to measure the rough surface shape to obtain slope function f(x), and with the coordinate of the measurement direction taken as x, the average slope angle θa is determined using following formulas (2) and (3). Here, L represents the measurement length, and Δa represents the tangent of average slope angle θa.

[0020]

[Formula 2]

$$\Delta a = (1/L)\int_0^L |(d/dx)f(x)|dx \quad \cdots \quad (2)$$

[Formula 3]

$$\theta a = \tan^{-1}(\Delta a) \quad \cdots \quad (3)$$

As shown in Figure 1, when the lens columns extending nearly in X-direction are formed on inner surface (24) or light exit plane (23) of light guiding member (3), examples of the lens columns include prism columns, lenticular lens columns, V-shaped slots, etc. Among them, the prism columns with nearly triangular cross-sectional shape in YZ direction are preferred. The prism columns with an isosceles triangle cross-section are even more preferred. Due to refraction or reflection function of the lens columns, it is possible to improve the directionality of the exit light from light guiding member (3) on the plane (XY plane) parallel to light incident plane (21). Also, by setting the shape of the lens columns appropriately, it is possible to have the desired exit light distribution on the YZ plane. For example, for the prism columns, by selecting appropriate prism apex angle, it is possible to control the exit light distribution on the YZ plane.

[0021]

According to the present invention, when prism columns are formed as lens columns on light guiding member (3), the prism apex angle is preferably in the range of 70-150°. The reason is as follows. When the prism apex angle is larger than 70°, the exit light from light guiding member (3) can be well condensed, so that the luminance of the face light source element can be well increased. On the other hand, by having the angle smaller than 150°, it is possible to have the desired spread of the exit light distribution correspond to the desired viewing angle range. Also, by having the prism apex angle in the aforementioned range, it is possible to have the exit light condensed to have a full width at half maximum of the luminous intensity in the range of 35-65° on the plane containing the principal exit light parallel to light source (1) (such as YZ plane), and it is possible to increase the luminance as a face light source element. Also, when prism columns are formed on inner surface (24), it is preferred that the prism apex angle be in the range of 70-80° or in the range of 100-150°. When prism columns are formed on light exit plane (23), it is preferred that the prism apex angle be in the range of 80-100°. Also, according to the present invention, light guiding member (3) is not limited to the plate shape shown in Figure 1. It may also be a wedge shape, ship-like shape, and various other shapes.

[0022]

Said light deflecting element (4) that forms the face light source element of the present invention is set on light exit plane (23) of light guiding member (3). Two principal surfaces (41), (42) of light deflecting element (4) are set opposite to each other, and parallel to XY plane. Among principal surfaces (41), (42), the principal surface facing light exit plane (23) of light guiding member (3) is taken as light deflecting element's incident plane (41), and the other principal surface is taken as light deflecting element's exit plane (42). As shown in Figure 1, on light deflecting element's incident plane (41), plural prism columns extending in the direction nearly parallel to light incident plane (21) of light guiding member (3) are set side-by-side consecutively to form a prism plane. It is not a necessity to have the prism columns parallel to light incident plane (21) of light guiding member (3). One may also adopt a scheme in which they extend in the direction at an angle of 15° or smaller with respect to light incident plane (21). As shown in Figure 2, the exit light from light guiding member (3) in the direction oblique to the normal of light exit plane (23) on XY plane is incident on light deflecting element (4), and due to the total reflection function at the prism plane, the light is subjected to inner-surface reflection, and its propagating direction is deflected to the direction of the normal of light exit plane (23). In this way, the light incident to light deflecting element (4) has its propagating direction deflected due to the total reflection function of the prism columns. Consequently, light exits light deflecting element (4) with a light intensity distribution that nearly corresponds to the

distribution of the intensity of the exit light from light guiding member (3). Consequently, exit light having an appropriate distribution can be deflected in the desired direction at a high efficiency by means of light guiding member (3).

[0023]

The prism apex angle of the prism columns formed on incident plane (41) of light deflecting element (4) is preferably in the range of 50-80°. When this range is observed, it is possible to have the exit light from light guiding member (3) deflected in the desired direction at a high efficiency. The prism apex angle is more preferably in the range of 55°-75°, or even more preferably in the range of 60°-70°. According to the present invention, light deflecting element (4) is not limited to the prism columns, and any type that can have the exit light from light guiding member (3) deflected to the desired direction (such as the normal of light exit plane (23)) may be adopted, such as lenticular lens columns, polygonal or conical lenses, fly's eye lenses, and other lens shapes. The prism columns with nearly triangular cross-sectional shape parallel the XZ plane are especially preferred.

[0024]

According to the present invention, light diffusion element (5) is set on exit plane (42) of light deflecting element (4), with its principal plane positioned parallel to XY plane. As said light diffusion element (5), it is necessary to guarantee an appropriate viewing angle range with improved distribution of the exit light while suppressing a decrease in the luminance as a face light source element. For this purpose, it is necessary to make use of light diffusion element (5) with diffusion rate of 5-10% with respect to the exit light from light deflecting element (4) on the plane (XZ plane) perpendicular to both light exit plane (23) and light incident plane (21) of light guiding member (3). The reason is as follows: if the diffusion rate of light diffusion element (5) is lower than 5%, it is impossible to have a sufficient spread in the distribution of the exit light, and it is impossible to guarantee a sufficient viewing angle range. If the diffusion rate is over 10%, the luminance decreases significantly.

[0025]

According to the present invention, the diffusion rate refers to the diffusion degree of light diffusion element (5) with respect to the exit light from light deflecting element (4). Consequently, the diffusion rate can be determined using following formula (4) from the luminous intensity of the light after passing through light diffusion element (5) on XZ plane in the direction 20° with respect to the normal of light exit plane (23) of light guiding member (3), the luminous intensity in the direction of 70°, and the luminous intensity in the direction of 5°.

[0026]

[Formula 4]

Diffusion rate (%) = [(luminous intensity at 20°)/cos(20°)+(luminous intensity at 70°)/cos(70°)]/2x(luminous intensity at 5°)/cos(5°) (4)

Also, according to the present invention, for light diffusion element (5), it is preferred that the total light transmittance be 65% or higher, or more preferably 70% or higher, or even more preferably 80% or higher. The reason is as follows: if the total light transmittance is 65% or higher, it is possible to suppress decrease in the luminance of the face light source element. Usually, for the light diffusion sheet used as light diffusion element (5), due to the trade-off relationship between the diffusion rate and the total light ray transmittance, it is preferred that said type of light diffusion element (5) be used. Types of light diffusion element (5) for use in the present invention include the type prepared by containing fine grains having light diffusion property in a transparent sheet, the type having mat-like fine bumps and dips on the surface of a transparent sheet, the type prepared by coating a layer of transparent beads or other fine light diffusion grains on the surface of the transparent sheet. Among these, the type having at least one of the incident plane for incidence of the exit light from light deflecting element (4) and the exit plane as a rough inner surface is preferred. By using said constitution of light diffusion element (5), it is possible to guarantee an appropriate spread of the viewing angle range, and at the same time, it is possible to prevent interference, moiré, glare, etc. due to adhesion with light deflecting /6 element (4) or the liquid crystal display element.

[0027]

Said light source (1) that forms the face light source element of the present invention is a linear light source that extends in Y direction. For example, one may make use of a fluorescence lamp or other line light source at a site with a certain distance from the generating source. By means of light source reflector (2) that covers light source (1), the light emitted from light source (1) is guided with minimal loss to light guiding member (3). This light source reflector may be made of a plastic film having a metal vapor deposited reflective layer on its surface, a plastic film containing a diffusion material, etc. As shown in Figure 1, light source reflector (2) is wound from out of the end edge portion of reflective element (6) via the outer surface of light source (1) to the exit plane's end edge portion of light deflecting element (4). Also, light source reflector (2) may also be wound from the outer surface of the end edge portion of reflective element (6) via the outer surface of light source (1) to the light exit plane's end edge portion of light guiding member (3). One may also set a reflective member of the same type as light source reflector (2) on the side end surface other than light incident plane (21) of light guiding member (3).

[0028]

Said reflective element (6) reflects the light exit from light guiding member (3) without reflection from inner surface (24) of light guiding member (3), and makes the light incident into light guiding member (3) from inner surface (24) again. For this purpose, like light source reflector (2), it is also prepared as a plastic sheet having a metal vapor deposited reflective layer on its surface, a plastic sheet containing a diffusion material, etc. According to the present invention, one may also adapt a scheme in which a reflective layer is formed by metal vapor deposition on inner surface (24) of light guiding member (3) in place of the reflective sheet as reflective element (6) as shown in Figure 1.

[0029]

According to the present invention, light guiding member (3), light deflecting element (4) and light diffusion element (5) may be made of synthetic resins with high light transmittance. Examples of the synthetic resins that may be used include methacrylic resin, acrylic resin, polycarbonate base resin, polyester base resin, polyvinyl chloride base resin, etc. Among them, methacrylic resin, which has high light transmittance, high heat resistance, good mechanical characteristics, excellent molding processability, etc., is especially preferred in making light guiding member (3). As a prescribed type of the methacrylic resin, a composition containing methyl methacrylate as the principal component, with content of methyl methacrylate of 80 wt% or more, is preferred.

[0030]

Also, when the surface structures, such as rough surface, lens surface, etc., are formed for light guiding member (3), light deflecting element (4), and light diffusion element (5), one may make use of a molding member having a prescribed surface structure for a transparent synthetic resin plate formed by hot pressing. Also, one may adopt a scheme in which the shape is formed at the same time by means of screen printing, extrusion molding, injection molding, etc. One may also adopt a scheme in which a thermosetting or photo-curing resin is used to form said structure. Especially, light deflecting element (4) may be prepared by forming a rough surface structure or lens structure made of active energy ray curable resin formed on a transparent base material, such as a transparent film or sheet of polyester base resin, acrylic resin, polycarbonate base resin, polyvinyl chloride base resin, polymethacrylimide base resin, etc. The sheet may be bonded and integrated on the individual transparent base material using bonding, fusion or another scheme. Examples of active energy ray curable resins include polyfunctional (meth)acrylate compounds, vinyl compounds, (meth)acrylates, allyl compounds, (meth)acrylic acid, etc.

[0031]

According to the present invention, by using light diffusion element (5) with a diffusion rate of 5-10% as the transparent base material for the lens sheet that forms the lens structure using an active energy ray curable resin on a transparent base material as aforementioned as light deflecting element (4), it is possible to have a single lens sheet work with both functions of light deflecting element (4) and light diffusion element (5), that is, it is possible to reduce the number of parts of the face light source element. However, from the viewpoint of obtaining a face light source element with an even higher luminance, it is preferred that light deflecting element (4) and light diffusion element (5) be set sequentially on light exit plane (23) of light guiding member (3). For the face light source element of the present invention with the aforementioned constitution, a liquid crystal display element is set on its light emitting surface (the exit plane of light diffusion element (5)) to form a liquid crystal display device.

[0032]

Application examples

In the following, an explanation will be given regarding the present invention with reference to application examples. In the following application examples, the properties are measured as follows.

[0033]

Measurement of luminance of face light source element, angle of principal exit light, full width at half maximum of the luminous intensity

The face light source element is placed on the measurement table of the XY luminance measurement system manufactured by Ono Technical Research Co., Ltd. The exit plane of the face light source element is divided to 54 divisions with interval of 20 mm (6 divisions in the vertical direction, 9 divisions in the lateral direction), and the luminance value is measured at each point by means of a luminance meter (BM-7 manufactured by Topcon Corp.). The average value is determined as the luminance of the face light source element. Also, the maximum value (MAX) and minimum value (MIN) at the 54 points is determined.

[0034]

Measurement of angle of principal exit light and full width at half maximum of the luminous intensity of light guiding member

The light guiding member is set on the measurement table of the XY luminance measurement system manufactured by Ono Technical Research Co., Ltd. On the light exit plane of the light guiding member, a black paper sheet with a 4-mm-diameter φ pinhole is positioned

such that the pinhole is located at the center of the light exit plane. The distance from a luminance meter (nt-1° manufactured by Minolta Corp.) is adjusted to have a measurement circle of 8-9 mm. Adjustment is performed by rotating the rotating shaft of the luminance meter with the pinhole at the center in the direction perpendicular to the light incident plane (longitudinal direction) and parallel to said plane (lateral direction). While the rotating shaft of the luminance meter is rotated at a step of 0.5° in the range of +80° ~ -80°, the luminous intensity distribution of the exit light is measured in the longitudinal direction and lateral direction. From the measured luminous intensity distribution, the angle of the principal exit light from the light exit plane of the light guiding member and the angle at the half maximum of the relative luminous intensity of the principal exit light are determined to get the full width at half maximum of the luminous intensity of the light guiding member. Also, when the distribution of the principal exit light spreads to over +80° or below -80°, the value obtained by doubling the absolute value of the difference between the peak angle of the principal exit light distribution and the angle corresponding to half maximum of the luminous intensity in the measurement range is taken as the full width at half maximum of the luminous intensity.

[0035] /7

Measurement of diffusion rate

The distribution of the exit light from the light diffusion element is measured using the XY luminance measurement system manufactured by Ono Technical Research Co., Ltd. From the distribution of the luminous intensity measured in this way, the luminous intensity is determined at 5°, 20°, and 70°, and the diffusion rate is determined using said formula (4).

[0036]

Measurement of total light ray transmittance

Reflectivity/transmittance meter Model HR-100 manufactured by Murakami Color Technology Research Lab. is used in the operation. A 19-mm-diameter collimated light beam (with parallel degree with respect to the optical axis of 3% or better) is irradiated, the light quantity (T1) and light quantity (T2) are measured when no light diffusion element is set at the entrance of an integrating sphere, and the percentage of T2/T1 is determined.

[0037]

Measurement of exit rate (α)

The luminous intensity is measured for each of the regions by dividing the portion from the light source side of the central portion of the light exit plane of the face light source element

to the other end surface side with an interval of 20 mm, and the exit rate is computed on the basis of said formula (1).

[0038]

Application Examples 1-2, Comparative Examples 1-2

A light guiding plate with one side formed as a rough surface was prepared by means of injection molding of acrylic resin (ACRYPET [transliteration] VH5#000 manufactured by Mitsubishi Rayon Co., Ltd.) using a mold with one surface formed as a mirror surface and the other surface formed as a rough surface prepared by means of blast processing with a blowing pressure in the range of 4-6 kg/cm^2 from a distance of 10 cm using glass pieces (FGB-120 manufactured by Fuji Seisakusho Co., Ltd.). The obtained light guiding plate is a wedge-shaped plate with thickness of 3 mm – 1 mm and with dimensions of 195 mm x 253 mm.

[0039]

On the mirror surface side of the obtained light guiding plate, a plasma layer with prism columns having a prism apex angle of 130° and pitch of 50 μm formed side-by-side from a UV curable resin with the minor edge of the light guiding plate with a length of 195 mm was formed. A fluorescent lamp (Backlight Unit BL-252 manufactured by Fujitsu Chemical Co., Ltd.) was set facing the side edge surface of the major edge with length of 253 mm of the light guiding member. Then, a light diffusion reflective film (E60 manufactured by Toray Industries, Inc.) was bonded on the other side end surface of the light guiding member, a reflective sheet was set facing the side (inner surface) where the prism columns are formed, and a light source reflector (reflective film manufactured by Reiko K.K.) [was also set]. The light exit rate of the light guiding member is 1.2%, the exit angle of the principal light ray of the exit light (the angle with respect to the normal of the light exit plane of the light guiding member) is 67.0°, and the full width at half maximum of the luminous intensity on the XZ plane is 27.5°.

[0040]

On the other hand, a light deflecting sheet was prepared by forming a prism plane composed of prism columns with a prism apex angle of 63° and pitch of 50 μm set side-by-side consecutively made of an acrylic UV curable resin on one surface of a 125-μm-thick polyester film. The obtained light deflecting sheet was set on the light guiding member such that the prism columns of the light deflecting sheet are perpendicular to the prism columns on the inner surface of the light guiding member, and with the prism plane of the light deflecting sheet facing the rough surface (light exit plane) of the light guiding member. The obtained face light source element has a normal luminance of 3430 Cd/m^2, a full width at half maximum of the luminous

intensity on the XZ plane of 27.5°, a full width at half maximum of the luminous intensity on the YZ plane of 41.0°, and a uniformity of 0.76.

[0041]

On the light deflecting sheet of the face light source element with the aforementioned constitution, a light diffusion sheet having the diffusion rate and total light transmittance listed in Table 1 was set. For each light diffusion sheet, a resin bead layer was coated on one surface of a polyester film to form a light diffusion layer having fine bumps and dips. Also, the light diffusion sheet was set such that the inner surface with respect to the surface on which the light diffusion layer is formed becomes the light deflecting sheet side. For the face light source element with said constitution, the full width at half maximum of the luminous intensity on the XZ plane and the full width at half maximum of the luminous intensity and normal luminance of YZ plane were measured, with the results listed in Table 1.

[0042]

<u>Application Examples 3-4</u>

In each of these application examples, a light deflecting sheet was prepared by forming a prism plane composed of prism columns having a prism apex angle of 63° and pitch of 50 μm made of an acrylic UV curable resin like in Application Example 1 on the surface on which the light diffusion layer of each of the two types of light diffusion sheets with diffusion rates of 6% and 8% used in Application Examples 1 and 2, respectively. The obtained light deflecting sheet was used to form the face light source element in the same way as in Application Example 1. Also, [as a control], the light diffusion sheet was not used. For the face light source elements prepared in this way, the full width at half maximum of the luminous intensity on XZ plane and the full width at half maximum of the luminous intensity and normal luminance on the YZ plane were measured, with results listed in Table 1.

[0043]

[Table I]

	光拡散シート		光度半値幅（°）		輝度
	拡散率(%)	全光線透過率(%)	XZ面	YZ面	(cd/m²)
実施例1	8	59.9	42.0	53.0	2070
実施例2	6	83.9	37.5	52.5	2370
実施例3	8	69.9	40.5	51.5	2000
実施例4	5	83.9	35.5	49.0	2150
比較例1	4	31.6	33.0	50.6	2840
比較例2	11	58.5	36.5	39.5	850

Key: 1 Application Example
2 Comparative Example
3 Light diffusion sheet
4 Diffusion rate
5 Total light transmittance
6 Full width at half maximum of the luminous intensity
7 XZ plane
8 YZ plane
9 Luminance

[0044]

Effect of the invention

The present invention provides a type of liquid crystal display device characterized by the fact that the decrease in the luminance of the face light source element can be minimized, an appropriate exit light distribution can be obtained corresponding to the desired viewing angle range, and the viewing angle range with a high luminance is wide.

Brief description of the figures

Figure 1 is a schematic oblique view illustrating an embodiment of the face light source element of the present invention.

Figure 2 is a partial cross-sectional view illustrating the optical function of the light deflecting element of the present invention.

Brief explanation of reference numbers

1 Light source
2 Light source reflector
3 Light guiding member
4 Light deflecting element
5 Light diffusion element
6 Reflective element

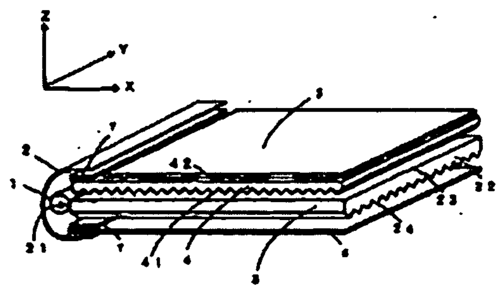

Figure 1

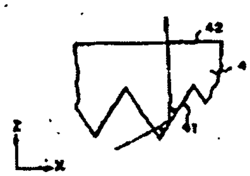

Figure 2